PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-107748
(43)Date of publication of application : 10.04.2002

(51)Int.Cl. G02F 1/1343
G02F 1/1337

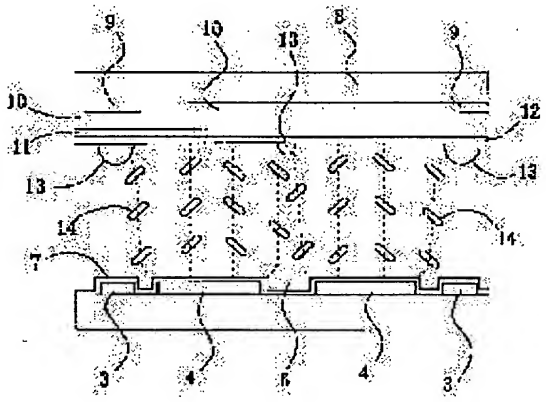
(21)Application number : 2000-296631
(22)Date of filing : 28.09.2000

(71)Applicant : SANYO ELECTRIC CO LTD
TOTTORI SANYO ELECTRIC CO LTD

(72)Inventor : SUZAKI TAKESHI
KASE HIROYUKI
MORI YOSHITAKA
TANAKA SHINICHIRO

(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a liquid crystal display device having a wide field angle where display unevenness like a burning phenomenon is prevented and plural domains are formed in one pixel.
SOLUTION: A first substrate 1 having a pixel electrode 4 and a second substrate 8 having a common electrode 11 are arranged so as to face each other, and liquid crystal 14 having negative dielectric constant anisotropy is held between both substrates 1 and 8, and both substrates 1 and 8 are coated with vertically oriented films 7 and 12, and liquid crystal molecules 14 are vertically arranged when an electric field is not applied to a liquid crystal layer, and they are obliquely arranged when it is applied to the liquid crystal layer. In this liquid crystal display device, the second substrate 8 is provided with projections 13 made of a conductor which regulates the inclination direction of liquid crystal molecules at the time of field application, and slits 6 are formed in the positions facing the projections 13 of the pixel electrode 4.



CLAIMS

[Claim(s)]
[Claim 1]The first substrate in which a picture element electrode was formed in a pixel which arranges a signal wire and a scanning line characterized by comprising the following to matrix form, and is surrounded with said signal wire and said scanning line, The second substrate in which a common electrode was formed, and an orienting film which performed perpendicular orientation processing laminated on said both boards, A liquid crystal display which a liquid crystal element inclines and is arranged when permittivity anisotropy pinched among said both boards had a negative liquid crystal layer, a liquid crystal element carries out vertical arrangement when an electric field is not impressed to said liquid crystal layer, and an electric field is impressed to said liquid crystal layer.
A projection of a conductor which is provided in said second substrate and regulates a slope direction of said liquid crystal element.
A slit formed in said projection of said picture element electrode, and a portion which counters.

[Claim 2]The liquid crystal display according to claim 1 forming a means to supply said common electrode and same electric potential to said projection.
[Claim 3]The liquid crystal display according to claim 2 said projection extending continuously to an end of said second substrate, and electrically connecting it with said common electrode at said end.
[Claim 4]The first substrate in which a picture element electrode was formed in a pixel which arranges a signal wire and a scanning line characterized by comprising the following to matrix form, and is surrounded with said signal wire and said scanning line, The second substrate in which a common electrode was formed, and an orienting film which performed perpendicular orientation processing laminated on said both boards, A liquid crystal display which a liquid crystal element inclines and is arranged when permittivity anisotropy pinched among said both boards had a negative liquid crystal layer, a liquid crystal element carries out vertical arrangement when an electric field is not impressed to said liquid crystal layer, and an electric field is impressed to said liquid crystal layer.
A projection which is provided in said second substrate and regulates a slope direction of said liquid crystal element.
A dielectric constant which has said projection of said picture element electrode, and the slit formed in a portion which counters and in which said projection is higher than a dielectric constant of said liquid crystal layer.

[Claim 5]The liquid crystal display according to claim 1 to 4 which forming said projection in linear shape, and arranging almost in parallel with said signal wire.
[Claim 6]The liquid crystal display according to claim 1 to 4 which forming said projection in linear shape, and arranging almost in parallel with said scanning line.
[Claim 7]The liquid crystal display according to claim 1 to 4, wherein said projection is formed in zigzag shape.
[Claim 8]The liquid crystal display according to claim 1 to 4 arranging ranging over two picture element electrodes which said projection is formed in zigzag shape along said signal wire, and adjoin said scanning line direction.
[Claim 9]The liquid crystal display according to claim 1 to 4 arranging ranging over two picture element electrodes which said projection is formed in zigzag shape along said scanning line, and adjoin in said direction of a signal wire.
[Claim 10]The liquid crystal display according to claim 1 to 9, wherein said projection is formed on said orienting film.

[Claim 11]The liquid crystal display according to claim 1 to 10 in which a portion in which said projection exists is characterized by removing an orienting film on said second substrate.
[Claim 12]The liquid crystal display according to claim 1 to 11, wherein said slit is located in a center section of said picture element electrode at least.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the liquid crystal display of the wide viewing angle which provided two or more domains in 1 pixel.
[0002]
[Description of the Prior Art]Generally the feature of a thin light weight and low power consumption is shown in a liquid crystal display, and it is broadly used from a personal digital assistant to large-sized television. A TN type liquid crystal display is often used as this liquid crystal display, and performance high as a display and quality are maintained.
[0003]In the case of a TN type TFT (ThinFilm Transistor) liquid crystal display, it has arranged so that the substrate with which the picture element electrode was formed, and the substrate with which the common electrode was formed may be countered, and the liquid crystal is enclosed between the substrates of this couple. Orientation treatment is performed to the orienting film on both boards by rubbing etc., and the orientation direction is set up differ from the orientation direction of the substrate which counters 90 degrees. A liquid crystal element is regulated by this orientation direction, and horizontal arrangement is carried out in that direction, and between substrates, horizontally, it is twisted 90 degrees and arranges. Although a polarizing plate counters a substrate and is arranged at the outside of each substrate, at the time of normally black mode, it is arranged so that the transmission axis of both polarizing plates may become a uniform direction, and it is arranged so that the transmission axis of both polarizing plates may make 90 degrees at the time of a normally white mode. Although the transmitted light which passed one polarizing plate turns into linear polarization and a liquid crystal layer is passed, since the liquid crystal element was twisted 90 degrees at this time and it has arranged, the transmitted light circles and a polarization direction is twisted 90 degrees. At this time, in normally black mode, since the transmitted light which passed the liquid crystal layer cannot pass the polarizing plate of another side, it becomes a dark display, but since the transmitted light which passed the liquid crystal layer at the time of a normally white mode can pass the polarizing plate of another side, it serves as clear display.
[0004]However, there were problems, like TN liquid crystal displays have large visual angle dependency. Then, the liquid crystal display of a wide viewing angle IPS (In-Plane Switching) type or VA (verticallyaligned) type is proposed rather than TN type. A liquid crystal negative in permittivity anisotropy is enclosed between the substrates of a couple, a picture element electrode is arranged at one substrate, and, as for the VA type liquid crystal display, the common electrode is arranged at the substrate of another side. Perpendicular orientation processing is performed to the orienting film on both boards, and when not impressing voltage to an electrode, the liquid crystal element is carrying out vertical arrangement. A polarizing plate is arranged at the outside of both boards, and it is set up so that the transmission axis of both polarizing plates may intersect perpendicularly. And since the liquid crystal element between substrates is carrying out vertical arrangement while not impressing voltage to an electrode, the transmitted light of linear polarization which passed one polarizing plate passes a liquid crystal layer as it is, and is interrupted with the polarizing plate of another side. Since the liquid crystal element between substrates carries out horizontal arrangement when voltage is impressed to an electrode, the double reflex of it is carried out, and the transmitted light of linear polarization which passed one polarizing plate turns into a passing beam of elliptical polarization, when passing a liquid crystal layer, and passes the polarizing plate of another side.
[0005]In order to improve further the angle of visibility of such a liquid crystal display, there is the method of forming two or more domains in 1 pixel, and in order to form this domain, the projection and the slot are provided in the pixel. This is indicated for example, in the patent No. 2947350 gazette. For example, when providing a projection in the substrate side of another side, the black matrix and the light filter were formed in the substrate of another side, and the light filter etc. are covered with the common electrode. The projection of the prescribed pattern was formed on this common electrode, and the orienting film is laminated to the common electrode and the projection. This projection is formed with the dielectric which is an insulating material of a low dielectric.
[0006]
[Problem(s) to be Solved by the Invention]However, when providing a projection in a pixel, a projection will exist between a picture element electrode and a common electrode, but since that projection is formed with the insulator of the low dielectric, the voltage impressed to a liquid crystal layer by this projection falls. Although impurity ion is floating to the liquid crystal layer, when the projection of a low dielectric exists on a common electrode, impurity ion focuses and adheres to the projection, and the printing phenomenon of a display occurs. Thus, a projection will be

the cause and display failure will arise.
[0007]Then, an object of this invention is to prevent display unevenness, such as printing, and to provide the liquid crystal display of the wide viewing angle in which two or more domains were formed in 1 pixel.
[0008]
[Means for Solving the Problem]In order that this invention may solve an aforementioned problem, the invention according to claim 1, The first substrate in which a picture element electrode was formed in a pixel which arranges a signal wire and a scanning line to matrix form, and is surrounded with a signal wire and a scanning line, The second substrate in which a common electrode was formed, and an orienting film which performed perpendicular orientation processing laminated on both boards, Permittivity anisotropy pinched among both boards has a negative liquid crystal layer, when an electric field is not impressed to a liquid crystal layer, a liquid crystal element carries out vertical arrangement, and when an electric field is impressed to a liquid crystal layer, a liquid crystal display which a liquid crystal element inclines and is arranged is characterized by comprising the following:
A projection of a conductor which is provided in the second substrate and regulates a slope direction of a liquid crystal element.
A slit formed in a projection of a picture element electrode, and a portion which counters.

[0009]The invention according to claim 2 formed a means to supply a common electrode and same electric potential to a projection.
[0010]The invention according to claim 3 extends continuously to an end of the second substrate, and a projection electrically connects it with a common electrode at the end.
[0011]The first substrate in which a picture element electrode was formed in a pixel which the invention according to claim 4 arranges a signal wire and a scanning line to matrix form, and is surrounded with a signal wire and a scanning line, The second substrate in which a common electrode was formed, and an orienting film which performed perpendicular orientation processing laminated on both boards, In a liquid crystal display which a liquid crystal element inclines and is arranged when permittivity anisotropy pinched among both boards had a negative liquid crystal layer, a liquid crystal element carries out vertical arrangement when an electric field is not impressed to a liquid crystal layer, and an electric field is impressed to a liquid crystal layer, It has a projection which is provided in the second substrate and regulates a slope direction of a liquid crystal element, a projection of a picture element electrode, and the slit formed in a portion which counters, and a projection is formed with a dielectric which has a dielectric constant higher than a dielectric constant of a liquid crystal layer.
[0012]A projection is formed in linear shape and the invention according to claim 5 is arranged almost in parallel with a signal wire.
[0013]A projection is formed in linear shape and the invention according to claim 6 is arranged almost in parallel with a scanning line.
[0014]As for the invention according to claim 7, a projection is formed in zigzag shape.
[0015]A projection is formed in zigzag shape along a signal wire, and the invention according to claim 8 is arranged ranging over two picture element electrodes contiguous to a scanning line direction.
[0016]A projection is formed in zigzag shape along a scanning line, and the invention according to claim 9 is arranged ranging over two picture element electrodes which adjoin in the direction of a signal wire.
[0017]As for the invention according to claim 10, a projection is formed on an orienting film.
[0018]As for the invention according to claim 11, an orienting film on the second substrate of a portion whose projection exists is removed.
[0019]As for the invention according to claim 12, a slit is located in a center section of the picture element electrode at least.
[0020]
[Embodiment of the Invention]Hereafter, the 1st example that is an embodiment of the invention is described based on figures. The sectional view of a liquid crystal display when drawing 1 impresses the top view of the first substrate and drawing 2 is not impressing the electric field, and drawing 3 are the sectional views of a liquid crystal display when an electric field is impressed. Drawing 2 and drawing 3 are the sectional views which met the A-A line of drawing 1.
[0021]1 is the first substrate of a glass substrate and the scanning line 2 and the signal wire 3 are wired by matrix form on this first substrate 1. The field surrounded with the scanning line 2 and the signal wire 3 is equivalent to 1 pixel, the picture element electrode 4 is arranged in this field, and the thin film transistor 5 linked to the picture element electrode 4 is formed in the intersection of the scanning line 2 and the signal wire 3. As for the picture element electrode 4, a slit is formed in a center section and this slit has become a signal wire and parallel. 7 is the orienting film laminated by the signal wire 3 and the picture element electrode 4, and perpendicular orientation processing is performed.
[0022]8 is the second substrate of a glass substrate, on the second substrate 8, the black matrix 9 is formed so that each pixel may be divided, and the light filter 10 is laminated corresponding to each pixel. On the light filter 10, the common electrodes 11, such as ITO, are laminated and the orienting film 12 in which perpendicular orientation processing was performed on the common electrode 11 is laminated.
[0023]On the orienting film 12, the projection 13 of the conductor is formed at the position which counters the slit 6 and the signal wire 3 of the picture element electrode 4. Drawing 4 is a figure showing typically the physical relationship of the projection 13 and the picture element electrode 4, and as shown in drawing 4, each projection 13

is arranged in parallel. This projection 13 is formed with the same material as the common electrodes 11, such as ITO, and has become same electric potential mostly with the common electrode 11. Here, in order to make the projection 13 and the common electrode 11 into same electric potential, the projection 13 extended continuously to the end of the second substrate 8, the field where the orienting film 12 does not exist in the end of the second substrate 8 was provided, and the common electrode 11 is connected with the projection 13 in the field. The composition which does not limit to this gestalt if the projection 13 serves as the common electrode 11 to same electric potential mostly, and electrically connects the common electrode 11 with the projection 13 within the viewing area of the second substrate 8, and the composition which carries out direct supply of the common electrode 11 and the same voltage to the projection 13 may be used.

[0024]When forming a projection with the insulator of a lower dielectric constant, a projection is made to counter the picture element electrode 4, and is arranged, but when forming the projection 13 with a conductor, the projection 13 is made to counter the portion in which the picture element electrode 4 does not exist, and is arranged. This is because the direction on which the liquid crystal element 14 falls down by the projection of a lower dielectric constant and the projection 13 of a conductor since distribution of the electric field of the projection 13 neighborhood differs becomes reverse. Drawing 5 is a figure showing operation of the liquid crystal element 14 of the projection 13 neighborhood. Drawing 5 (a) shows the case where the projection 13a is a conductor, and drawing 5 (b) shows the time of the projection 13b being an insulator of a lower dielectric constant here. Permittivity anisotropy is negative, and when an electric field does not occur, vertical arrangement of the liquid crystal element 14 is carried out. Although the line of electric force A arises perpendicularly to the surface of the projection 13 at the time of the projection 13a of a conductor, the line of electric force B arises almost in parallel to the slant face of the projection 13b at the time of the projection 13b of a lower dielectric constant. And the liquid crystal element 14 will incline in the direction of the arrow shown in drawing 5, and it will be in a parallel condition mostly with the slant face of the projection 13a at the time of the projection 13a of a conductor, and will be in a perpendicular state mostly with the slant face of the projection 13b at the time of the projection 13b of a lower dielectric constant. Even when the projection 13a of a conductor is covered by the vertical orientation films 12, the liquid crystal element 14 carries out the same operation as the case where the projection 13a is not covered with the orienting film 12, but. The movement magnitude of the liquid crystal element 14 when an electric field is not impressed, in order for the liquid crystal element 14 to be influenced by the orienting film 12 and to arrange almost vertically to the slant face of the projection 13a, when an electric field is impressed becomes large, and since the array state of the liquid crystal element 14 changes, it will take time. Therefore, the direction which does not laminate the orienting film 12 on the projection 13a of a conductor changes to an array state with the liquid crystal element 14 certainly optimal in a short time at the time of impression of an electric field.

[0025]The projection 13 which countered the signal wire 3 is greatly formed a little rather than the projection 13 made to counter the slit 6. Although it is because this has the interval of the picture element electrode 4 which adjoins on both sides of the signal wire 3 larger than the width of the slit 6, each projection 13 may be made into the same size. What is necessary is for the height just to be 1 micrometers or more, when the width of the projection 13 is 10 micrometers, as it just inclines in the direction it was decided that the liquid crystal element 14 located in the projection 13 neighborhood with the line of electric force from the slant face of the projection 13 would be when the size of the projection 13 impresses an electric field, for example, shown in drawing 6.

[0026]Although the projection 13a is formed with the conductor in the 1st example, a projection may be formed with the dielectric which has a dielectric constant higher than the dielectric constant of a liquid crystal. In the projection of high permittivity, distribution of the electric field near a projection becomes closer to the state of the projection 13a of a conductor than the projection 13b of a lower dielectric constant, and falls on the slant face of a projection, and parallel like [operation of the liquid crystal element 14 near a projection] the time of the projection 13a of a conductor.

[0027]Among both the substrates 1 and 8, a liquid crystal negative in permittivity anisotropy is enclosed, and when not impressing voltage to the picture element electrode 4, as the liquid crystal element 14 shows drawing 2, vertical arrangement is carried out in response to the influence of the vertical orientation films 7 and 12. At this time, although the projection 13 is not covered with the orienting film 12, the liquid crystal element 14 of the projection 13 neighborhood is influenced by the array state of the adjoining liquid crystal element 14, and carries out vertical arrangement of it. Both the substrates 1 and 8 are put with the polarizing plate of the couple which is not illustrated, and when it has arranged so that the transmission axis of the polarizing plate may intersect perpendicularly, the transmitted light which passed one polarizing plate passes a liquid crystal layer, without carrying out a double reflex with the liquid crystal element 14, and is intercepted with the polarizing plate of another side.

[0028]When voltage is impressed to the picture element electrode 4, as it is shown in drawing 3, an electric field occurs between the picture element electrode 4 and the common electrode 11. The dotted line of drawing 3 shows line of electric force. Since the projections 13 are the common electrode 11 and same electric potential at this time, an electric field occurs perpendicularly to the surface of the projection 13, and the liquid crystal element 14 of the projection 13 neighborhood inclines so that an electric field flux line and that major axis may cross at right angles. When it observes in the section shown in drawing 3, an electric field occurs toward the slanting upper part from the end of the picture element electrode 4, and the liquid crystal element 14 near the end of the picture element electrode 4 inclines so that the line of electric force from an end and the major axis may cross at right angles. At this time, the liquid crystal element 14 of the projection 13 neighborhood and the liquid crystal element 14 near the end of the picture element electrode 4 incline in a uniform direction, and the liquid crystal element 14 which adjoins

in response to the influence of this inclined liquid crystal element 14 also inclines in a uniform direction. If it arranges so that it may not become the major axis direction of the liquid crystal element 14 and parallel which inclined the transmission axis of the polarizing plate of a couple, with the liquid crystal element 14, the double reflex of the transmitted light which passed one polarizing plate will be carried out, and it will pass the polarizing plate of another side. Since an operation of the double reflex by the liquid crystal element 14 becomes the largest when the transmission axis of a polarizing plate is leaned 45 degrees and has been arranged to the major axis direction of this inclined liquid crystal element 14, a white display can be performed efficiently. Since the liquid crystal element 14 inclines almost in parallel with the slant face of the projection 13, the slope direction of the liquid crystal element 14 becomes reverse bordering on the projection 13. Therefore, in a pixel, several domains where the slope directions of the liquid crystal element 14 differ exist, and the view angle characteristic is compensated mutually.

[0029]Thus, since the projection of the conductor was provided, though it is the composition of generating two or more domains in a pixel, a voltage drop can be prevented and impurity ion can be prevented from focusing and adhering.

[0030]Next, the 2nd example is described based on drawing 7. Drawing 7 is a mimetic diagram showing the physical relationship of the picture element electrode 4 and the projection 16, and is carrying out the same composition as the 1st example except the slit 15 of the picture element electrode 4, and the shape of the projection 16. The slit 15 parallel to the scanning line 2 is formed in the center portion of this picture element electrode 4, and the projection 16 is formed in the slit 15 and the scanning line 2, and the position that counters. This projection 16 is also formed on the orienting film 12 with a conductor, and is electrically connected with the common electrode 11 in the portion in which it extends continuously to the end of the second substrate 8, and the orienting film 12 does not exist. And if an electric field occurs between the picture element electrode 4 and the common electrode 11, bordering on the projection 16, the liquid crystal element 14 will incline to an opposite direction, and will form two or more domains in a pixel.

[0031]Next, the 3rd example is described based on drawing 8. Drawing 8 is a mimetic diagram showing the physical relationship of the picture element electrode 4 and the projection 18, and is carrying out the same composition as the 1st example except the slit 17 of the picture element electrode 4, and the shape of the projection 18. The projection 18 of this conductor was formed in zigzag shape, and has extended continuously to the end of the second substrate 8 along the signal wire 3. The projection 18 has been arranged ranging over the two picture element electrodes 4 which adjoin a scanning line 2-way, and each projection 18 is located in a line in parallel. The slit 17 is formed in the position which corresponds to the picture element electrode 4 with the projection 18. And if an electric field occurs between the picture element electrode 4 and the common electrode 11, bordering on the projection 18, the liquid crystal element 14 will incline to an opposite direction, and will form two or more domains in a pixel. If 1 pixel is observed at this time, in 1 pixel, the projection 18a of two sides located in a line in parallel and the projection 18b of two sides mutually located in a line in parallel toward a different direction from that projection 18a exist. That is, in order for 2 sets of projections 18a and 18b which were suitable in the direction which is different in 1 pixel, respectively to exist, and for the liquid crystal element 14 to incline to an opposite direction among 1 set each of projections 18 and to form two domains, Four domains can be formed in 1 pixel and a wide viewing angle liquid crystal display can be realized.

[0032]Although the projection 18 has been arranged along the signal wire 3 in this example, the composition arranged along the scanning line 2 may be used. In that case, a projection is arranged ranging over the two picture element electrodes 4 which adjoin each other in the signal wire 3 direction, and each projection is put in order in parallel.

[0033]Next, the 4th example is described based on drawing 9. Drawing 9 is a sectional view of a liquid crystal display, and corresponds to drawing 2 of the 1st example. Although the 4th example differs in the method of connection the 1st example, the common electrode 11, and the projection 19, other composition is the same as the 1st example. The 4th example forms the projection 19 of a conductor on the common electrode 11 except for the orienting film 12 of a portion in which the projection 19 is located. Since the projection 19 can connect with the common electrode 11 certainly at this time, the projection 19 becomes the common electrode 11 and same electric potential. After forming the common electrode 11 on the second substrate 8, the orienting film 12 is laminated, only the portion in which the projection 19 is located removes the orienting film 12, and the method of formation this projection 19 forms the projection 19 after that. In this case, in consideration of the mask gap at the time of forming projection 19 grade, it is necessary to remove the orienting film 12 widely a little. As the method of other formation, the projection 19 is previously formed on the common electrode 11, and after covering the common electrode 11 and the projection 19 with the orienting film 12, only the portion of the projection 19 may remove the orienting film 12. Since the projection 19 is certainly connected to the common electrode 11 regardless of the laminating condition of the orienting film 12 and a proper-shaped thing can be formed at this time, the portion which removes the orienting film 12 can be made into the minimum. For a touching [all the projections 19]-common electrode 11 reason, although arranged corresponding to the slit 6 and the signal wire 3 of the picture element electrode 4, this projection 19 may not be made to extend continuously to the end of the second substrate 8, or it may divide selectively and it may be provided. And when voltage is impressed to the picture element electrode 4, the liquid crystal element 14 of the projection 19 neighborhood operates like the 1st example, and forms two or more domains in 1 pixel.

[0034]Since the projection was formed in the common electrode side by this invention as mentioned above, when an electric field occurs between a picture element electrode and a common electrode, two or more domains can be

formed in each pixel, and a wide viewing angle liquid crystal display is made. Since the projection is furthermore formed with the conductor, a projection becomes a common electrode and same electric potential, the voltage drop produced when impurity ion can be prevented from sticking to a projection intensively and the projection of a lower dielectric constant exists in the part in a pixel can be prevented, and a uniform electric field is generated between a picture element electrode and a common electrode — things can be carried out.

[0035]In the case of the projection of a conductor, the example explained, but a projection may be formed with the dielectric which has a dielectric constant higher than the dielectric constant of a liquid crystal, and the same effect as the projection of a conductor can be acquired also in this case. In the projection of this invention, it is also possible for a projection to counter near the end of a picture element electrode, to just be arranged, and to take gestalten other than an example.

[0036]

[Effect of the Invention]According to this invention, even when a projection is provided so that two or more domains may be formed in a pixel, it can reduce that impurity ion adheres to a projection intensively, and a phenomenon can be prevented for printing. The voltage drop resulting from a projection can be decreased and a good display can be obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a top view of the first substrate of the liquid crystal display which is the 1st example of this invention.
[Drawing 2]It is a sectional view of a liquid crystal display when not impressing the electric field.
[Drawing 3]It is a sectional view of a liquid crystal display when an electric field is impressed.
[Drawing 4]It is a mimetic diagram showing the physical relationship of the picture element electrode of a liquid crystal device and projection which are the 1st example.
[Drawing 5]It is a figure explaining operation of the liquid crystal element located near the projection at the time of impressing voltage.
[Drawing 6]It is an expanded sectional view of a projection of the 1st example.
[Drawing 7]It is a mimetic diagram showing the physical relationship of the picture element electrode of a liquid crystal display and projection which are the 2nd example.
[Drawing 8]It is a mimetic diagram showing the physical relationship of the picture element electrode of a liquid crystal display and projection which are the 3rd example.
[Drawing 9]It is a sectional view when not impressing the electric field of the liquid crystal display which is the 4th example.
[Description of Notations]
1 The first substrate
2 Scanning line
3 Signal wire
4 Picture element electrode
6, 15, and 17 Slit
7 and 12 Orienting film
8 The second substrate
11 Common electrode
13, 16, 18, and 19 Projection
14 Liquid crystal element

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－107748
(P2002－107748A)
(43)公開日　平成14年4月10日(2002.4.10)

(51)Int.Cl.'		識別記号	FI			ﾃｰﾏｺｰﾄﾞ(参考)
G02F	1/1343		G02F	1/1343		2H090
	1/1337	520		1/1337	520	2H092

審査請求　未請求　請求項の数12　ＯＬ　（全８頁）

(21)出願番号　特願2000－296631(P2000－296631)

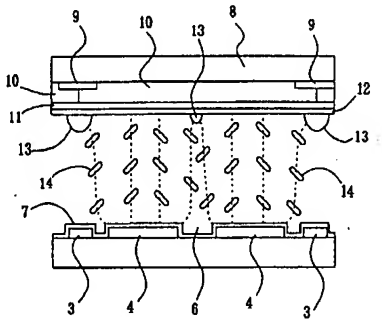
(22)出願日　平成12年9月28日(2000.9.28)

(71)出願人　000001889
三洋電機株式会社
大阪府守口市京阪本通２丁目５番５号
(71)出願人　000214892
鳥取三洋電機株式会社
鳥取県鳥取市南吉方３丁目201番地
(72)発明者　須崎　剛
鳥取県鳥取市南吉方３丁目201番地　鳥取三洋電機株式会社内
(74)代理人　100111383
弁理士　芝野　正雅

最終頁に続く

(54)【発明の名称】　液晶表示装置

(57)【要約】
【目的】　焼付き現象等の表示ムラを防止すると共に、１画素内に複数のドメインを形成した広視野角の液晶表示装置を提供することを目的とする。
【構成】　画素電極４を有する第一基板１と共通電極１１を有する第二基板８を対向配置し、両基板１、８間に誘電率異方性が負の液晶１４を挟持する。両基板１、８を垂直配向膜７、１２で覆い、液晶層に電界が印加されていないときは液晶分子１４が垂直配列し、液晶層に電界が印加されたときは液晶分子１４が傾斜して配列する液晶表示装置において、第二基板８に電界印加時の液晶分子１４の傾斜方向を規制する導電体の突起１３を設け、画素電極４には突起１３と対向する部分にスリット６を形成する。



1

【特許請求の範囲】
【請求項１】　信号線と走査線をマトリクス状に配置し、前記信号線と前記走査線で囲まれる画素内に画素電極を形成した第一基板と、共通電極を形成した第二基板と、前記両基板上に積層される垂直配向処理を施した配向膜と、前記両基板間に挟持される誘電率異方性が負の液晶層とを有し、前記液晶層に電界が印加されていないときは液晶分子が垂直配列し、前記液晶層に電界が印加されたときは液晶分子が傾斜して配列する液晶表示装置において、前記第二基板に設けられ且つ前記液晶分子の傾斜方向を規制する導電体の突起と、前記画素電極の前記突起と対向する部分に形成されたスリットとを有することを特徴とする液晶表示装置。
【請求項２】　前記突起に前記共通電極と同電位を供給する手段を設けたことを特徴とする請求項１記載の液晶表示装置。
【請求項３】　前記突起は前記第二基板の端部まで連続的に延在し、前記端部で前記共通電極と電気的に接続することを特徴とする請求項２記載の液晶表示装置。
【請求項４】　信号線と走査線をマトリクス状に配置し、前記信号線と前記走査線で囲まれる画素内に画素電極を形成した第一基板と、共通電極を形成した第二基板と、前記両基板上に積層される垂直配向処理を施した配向膜と、前記両基板間に挟持される誘電率異方性が負の液晶層とを有し、前記液晶層に電界が印加されていないときは液晶分子が垂直配列し、前記液晶層に電界が印加されたときは液晶分子が傾斜して配列する液晶表示装置において、前記第二基板に設けられ且つ前記液晶分子の傾斜方向を規制する突起と、前記画素電極の前記突起と対向する部分に形成されたスリットとを有し、前記突起は前記液晶層の誘電率よりも高い誘電率を有する誘電体によって形成されていることを特徴とする液晶表示装置。
【請求項５】　前記突起が直線状に形成され、且つ前記信号線とほぼ平行に配置されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。
【請求項６】　前記突起が直線状に形成され、且つ前記走査線とほぼ平行に配置されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。
【請求項７】　前記突起がジグザグ状に形成されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。
【請求項８】　前記突起が前記信号線に沿ってジグザグ状に形成されると共に前記走査線方向に隣接する２つの画素電極にまたがって配置されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。
【請求項９】　前記突起が前記走査線に沿ってジグザグ状に形成されると共に前記信号線方向に隣接する２つの画素電極にまたがって配置されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。

2

【請求項１０】　前記突起が前記配向膜上に形成されていることを特徴とする請求項１乃至請求項９記載の液晶表示装置。
【請求項１１】　前記突起が存在する部分は前記第二基板上の配向膜が除去されていることを特徴とする請求項１乃至請求項１０記載の液晶表示装置。
【請求項１２】　前記スリットが少なくとも前記画素電極の中央部に位置することを特徴とする請求項１乃至請求項１１記載の液晶表示装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は１画素内に複数のドメインを設けた広視野角の液晶表示装置に関する。
【０００２】
【従来の技術】一般に液晶表示装置には薄型軽量、低消費電力という特徴があり、携帯端末から大型テレビに至るまで幅広く利用されている。この液晶表示装置としてＴＮ型の液晶表示装置がよく使われ、表示装置として高い性能、品質を維持している。
【０００３】ＴＮ型のＴＦＴ（ThinFilm Transistor）液晶表示装置の場合、画素電極が形成された基板と共通電極が形成された基板を対向するように配置し、この一対の基板間に液晶を封入している。両基板上の配向膜にはラビング等によって配向処理が行われ、その配向方向は対向する基板の配向方向と９０度異なるように設定されている。液晶分子はこの配向方向に規制されてその方向に水平配列し、基板間では水平方向に９０度捻れて配列する。各基板の外側には偏光板が基板に対向して配置されるが、ノーマリブラックモードのときは両偏光板の透過軸が同一方向になるように配置され、ノーマリホワイトモードのときには両偏光板の透過軸が９０度をなすように配置される。一方の偏光板を通過した透過光は直線偏光となって液晶層を通過するが、このとき液晶分子が９０度捻れて配列しているので透過光は旋廻して偏光方向が９０度捻れる。このときノーマリブラックモードでは液晶層を通過した透過光は他方の偏光板を通過できないので暗表示になるが、ノーマリホワイトモードのときは液晶層を通過した透過光は他方の偏光板を通過できるので明表示となる。
【０００４】しかしＴＮ型液晶表示装置等は視角依存性が大きい等の問題があった。そこでＴＮ型よりも広視野角なＩＰＳ（In-Plane Switching）型やＶＡ（vertically aligned）型の液晶表示装置が提案されている。ＶＡ型の液晶表示装置は、一対の基板間に誘電率異方性が負の液晶が封入され、一方の基板には画素電極が、他方の基板には共通電極が配置されている。両基板上の配向膜には垂直配向処理が施され、電極に電圧を印加しないときは液晶分子が垂直配列している。両基板の外側には偏光板が配置され、両偏光板の透過軸が直交するように設定されている。そして電極に電圧を印加していないとき

は基板間の液晶分子が垂直配列しているので、一方の偏光板を通過した直線偏光の透過光がそのまま液晶層を通過して他方の偏光板によって遮られる。また電極に電圧を印加したときは基板間の液晶分子が水平配列するので、一方の偏光板を通過した直線偏光の透過光は液晶層を通過するときに複屈折され楕円偏光の通過光になり、他方の偏光板を通過する。

【0005】こうした液晶表示装置の視野角を更に改善するために、1画素内に複数のドメインを形成する方法があり、このドメインを形成するために画素内に突起や溝を設けている。これは例えば特許第2947350号公報に記載されている。例えば、他方の基板側に突起を設ける場合、他方の基板にはブラックマトリックスとカラーフィルタを形成し、カラーフィルタ等を共通電極で覆っている。この共通電極上に所定パターンの突起を形成し、共通電極及び突起に配向膜を積層している。この突起は低誘電性の絶縁物である誘電体で形成されている。

【0006】

【発明が解決しようとする課題】しかし画素内に突起を設ける場合、画素電極と共通電極の間に突起が存在することになるが、その突起が低誘電性の絶縁体で形成されているため、この突起によって液晶層に印加される電圧が低下する。また、液晶層には不純物イオンが浮遊しているが、共通電極上に低誘電性の突起が存在する場合は不純物イオンがその突起に集中して付着してしまい、表示の焼付き現象が発生する。このように突起が原因となって表示不良が生じてしまう。

【0007】そこで本発明は、焼付き等の表示ムラを防止すると共に、1画素内に複数のドメインを形成した広視野角の液晶表示装置を提供することを目的とする。

【0008】

【課題を解決するための手段】上記課題を解決するために請求項1記載の発明は、信号線と走査線をマトリクス状に配置し、信号線と走査線で囲まれる画素内に画素電極を形成した第一基板と、共通電極を形成した第二基板と、両基板上に積層される垂直配向処理を施した配向膜と、両基板間に挟持される誘電率異方性が負の液晶層とを有し、液晶層に電界が印加されていないときは液晶分子が垂直配列し、液晶層に電界が印加されたときは液晶分子が傾斜して配列する液晶表示装置において、第二基板に設けられ且つ液晶分子の傾斜方向を規制する突起と、画素電極の突起と対向する部分に形成されたスリットとを有し、突起は液晶層の誘電率よりも高い誘電率を有する誘電体によって形成されていることを特徴とする。

【0012】また請求項5記載の発明は、突起が直線状に形成され、且つ信号線とほぼ平行に配置されていることを特徴とする。

【0013】また請求項6記載の発明は、突起が直線状に形成され、且つ走査線とほぼ平行に配置されていることを特徴とする。

【0014】また請求項7記載の発明は、突起がジグザグ状に形成されていることを特徴とする。

【0015】また請求項8記載の発明は、突起が信号線に沿ってジグザグ状に形成されると共に走査線方向に隣接する2つの画素電極にまたがって配置されていることを特徴とする。

【0016】また請求項9記載の発明は、突起が走査線に沿ってジグザグ状に形成されると共に信号線方向に隣接する2つの画素電極にまたがって配置されていることを特徴とする。

【0017】また請求項10記載の発明は、突起が配向膜上に形成されていることを特徴とする。

【0018】また請求項11記載の発明は、突起が存在する部分の第二基板上の配向膜が除去されていることを特徴とする。

【0019】また請求項12記載の発明は、スリットが少なくとも画素電極の中央部に位置することを特徴とする。

【0020】

【発明の実施の形態】以下、本発明の実施の形態である第1実施例を図に基づいて説明する。図1は第一基板の平面図、図2は電界を印加していないときの液晶表示装置の断面図、図3は電界を印加したときの液晶表示装置の断面図である。なお、図2及び図3は図1のA－A線に沿った断面図である。

【0021】1はガラス基板の第一基板であり、この第一基板1上には走査線2と信号線3がマトリクス状に配線されている。走査線2と信号線3で囲まれる領域が1画素に相当し、この領域内に画素電極4が配置され、走査線2と信号線3の交差部には画素電極4と接続する薄膜トランジスタ5が形成される。画素電極4は中央部にスリットが形成され、このスリットは信号線と平行になっている。7は信号線3や画素電極4に積層された配向膜であり、垂直配向処理が施されている。

【0022】8はガラス基板の第二基板であり、第二基板8上には各画素を区切るようにブラックマトリックス9が形成され、各画素に対応してカラーフィルタ10が積層されている。カラーフィルタ10上には例えばITOなどの共通電極11が積層され、共通電極11上には垂直配向処理が施された配向膜12が積層されている。

【0023】配向膜12上には画素電極4のスリット6と信号線3に対向する位置に導電体の突起13が形成されている。図4は突起13と画素電極4の位置関係を模式的に示した図であり、図4に示すように各突起13は並列に配置されている。この突起13はITO等の共通電極11と同じ材料で形成され、共通電極11とほぼ同電位になっている。ここでは突起13と共通電極11とを同電位にするために、突起13が第二基板8の端部まで連続的に延在し、第二基板8の端部に配向膜12が存在しない領域を設け、その領域で突起13と共通電極11を接続している。なお突起13が共通電極11とほぼ同電位になればこの形態に限定するものではなく、突起13と共通電極11を第二基板8の表示領域内で電気的に接続する構成や、突起13に共通電極11と同じ電圧を直接供給する構成でもよい。

【0024】突起を低誘電率の絶縁体で形成する場合は突起を画素電極4に対向させて配置するが、突起13を導電体で形成する場合は突起13を画素電極4が存在しない部分に対向させて配置する。これは低誘電率の突起と導電体の突起13とでは突起13付近の電界の分布が異なるために、液晶分子14の倒れる方向が逆になるためである。図5は突起13付近の液晶分子14の動作を示す図である。ここで図5（a）は突起13aが導電体の場合を示し、図5（b）は突起13bが低誘電率の絶縁体のときを示す。また液晶分子14は誘電率異方性が負であり、電界が発生しないときは垂直配列している。導電体の突起13aのときは電気力線Aが突起13の表面に対して垂直方向に生じるが、低誘電率の突起13bのときは電気力線Bが突起13bの斜面に対してほぼ平行方向に生じる。そして液晶分子14は図5に示す矢印の方向に傾き、導電体の突起13aのときは突起13aの斜面とほぼ平行状態になり、低誘電率の突起13bのときは突起13bの斜面とほぼ垂直状態になる。なお導電体の突起13aを垂直配向膜12で覆った場合でも液晶分子14は突起13aを配向膜12で覆っていない場合と同様の動作をするが、電界が印加されないときに液晶分子14が配向膜12に影響されて突起13aの斜面に対してほぼ垂直に配列するため、電界を印加したときの液晶分子14の移動量が大きくなり、液晶分子14の配列状態が変化するために時間がかかってしまう。したがって導電体の突起13a上に配向膜12を積層しない方が電界の印加時に液晶分子14が短時間で確実に最適な配列状態に変化する。

【0025】信号線3に対向した突起13はスリット6に対向させた突起13よりも若干大きく形成されている。これは信号線3を挟んで隣接する画素電極4の間隔がスリット6の幅よりも広いためであるが、各突起13を同じ大きさにしても良い。突起13の大きさは、電界を印加した際に突起13の斜面からの電気力線によって突起13付近に位置する液晶分子14が決まった方向に傾斜できればよく、例えば図6に示すように突起13の幅が10μmの場合、高さは1μm以上あればよい。

【0026】第1実施例では突起13aを導電体で形成しているが、突起を液晶の誘電率よりも高い誘電率を有する誘電体で形成しても良い。高誘電率の突起の場合、突起付近の電界の分布は低誘電率の突起13bよりも導電体の突起13aの状態に近くなり、突起付近の液晶分子14の動作も導電体の突起13aのときと同様に突起の斜面と平行に倒れる。

【0027】両基板1、8間には誘電率異方性が負の液晶が封入され、画素電極4に電圧を印加しないときは液晶分子14が図2に示すように垂直配向膜7、12の影響を受けて垂直配列する。このとき突起13は配向膜12で覆われていないが、突起13付近の液晶分子14は隣接する液晶分子14の配列状態に影響されて垂直配列する。図示しない一対の偏光板で両基板1、8を挟み込み、その偏光板の透過軸が直交するように配置したとき、一方の偏光板を通過した透過光は液晶分子14によって複屈折されることなく液晶層を通過し、他方の偏光板で遮断される。

【0028】画素電極4に電圧を印加したときは図3に示すように、画素電極4と共通電極11の間に電界が発生する。図3の点線は電気力線を示す。このとき突起13が共通電極11と同電位であるため突起13の表面に対して垂直方向に電界が発生し、突起13付近の液晶分子14はその長軸が電界力線と直交するように傾斜する。また図3に示す断面で観察したときに、画素電極4の端部から斜め上方に向かって電界が発生し、画素電極4の端部付近の液晶分子14はその長軸が端部からの電気力線と直交するように傾斜する。このとき突起13付近の液晶分子14と画素電極4の端部付近の液晶分子14は同一方向に傾斜し、この傾斜した液晶分子14の影響を受けて隣接する液晶分子14も同一方向に傾斜する。一対の偏光板の透過軸を傾斜した液晶分子14の長軸方向と平行にならないように配置すると、一方の偏光板を通過した透過光は液晶分子14によって複屈折され他方の偏光板を通過する。この傾斜した液晶分子14の長軸方向に対して偏光板の透過軸を45度傾けて配置したとき、液晶分子14による複屈折の作用が最も大きくなるため、効率良く白表示ができる。液晶分子14は突起13の斜面とほぼ平行に傾斜するので、突起13を境にして液晶分子14の傾斜方向が逆になる。したがって画素内には液晶分子14の傾斜方向の異なる複数のドメ

インが存在し、互いに視野角特性を補償し合っている。

【００２９】このように導電体の突起を設けたので、画素内に複数のドメインを発生させる構成でありながら、電圧降下を防止でき且つ不純物イオンが集中して付着することを防止できる。

【００３０】次に第２実施例を図７に基づいて説明する。図７は画素電極４と突起１６との位置関係を示す模式図であり、画素電極４のスリット１５と突起１６の形状以外は第１実施例と同じ構成をしている。この画素電極４の中央部分に走査線２と平行なスリット１５が形成され、突起１６はスリット１５及び走査線２と対向する位置に形成される。この突起１６も導電体で配向膜１２上に形成され、第二基板８の端部まで連続的に延在して配向膜１２の存在しない部分で共通電極１１と電気的に接続されている。そして画素電極４と共通電極１１の間に電界が発生すると突起１６を境にして液晶分子１４が逆方向に傾斜し、画素内に複数のドメインを形成する。

【００３１】次に第３実施例を図８に基づいて説明する。図８は画素電極４と突起１８との位置関係を示す模式図であり、画素電極４のスリット１７と突起１８の形状以外は第１実施例と同じ構成をしている。この導電体の突起１８はジグザグ状に形成され、信号線３に沿って第二基板８の端まで連続的に延在している。また突起１８は走査線２方向に隣り合う２つの画素電極４にまたがって配置され、各突起１８は平行に並んでいる。画素電極４には突起１８と対応する位置にスリット１７が形成されている。そして画素電極４と共通電極１１の間に電界が発生すると突起１８を境にして液晶分子１４が逆方向に傾斜し、画素内に複数のドメインを形成する。このとき１画素を観察すると、１画素内には平行に並んだ２辺の突起１８ａと、その突起１８ａと異なる方向に向き且つ互いに平行に並んだ２辺の突起１８ｂが存在する。つまり１画素内にそれぞれ異なる方向に向いた２組の突起１８ａ、１８ｂが存在することになり、各１組の突起１８の間で液晶分子１４が逆方向に傾斜して２つのドメインを形成するため、１画素内に４つのドメインを形成することができ、広視野角な液晶表示装置を実現できる。

【００３２】この実施例では突起１８を信号線３に沿って配置したが、走査線２に沿って配置する構成でもよい。その場合、突起は信号線３方向に隣り合う２つの画素電極４にまたがって配置され、各突起は平行に並べられる。

【００３３】次に第４実施例を図９に基づいて説明する。図９は液晶表示装置の断面図であり、第１実施例の図２に対応する。第４実施例は第１実施例と共通電極１１と突起１９の接続の仕方が異なるが、その他の構成は第１実施例と同じである。第４実施例は突起１９が位置する部分の配向膜１２を除き、共通電極１１上に導電体の突起１９を形成している。このとき突起１９が確実に共通電極１１に接続できるため、突起１９が共通電極１１と同電位になる。この突起１９の形成の仕方は、第二基板８上に共通電極１１を形成した後に配向膜１２を積層し、突起１９が位置する部分だけ配向膜１２を除去し、その後に突起１９を形成する。この場合、突起１９等を形成する際のマスクずれを考慮して、若干広く配向膜１２を除去する必要がある。他の形成の仕方として、共通電極１１上に先に突起１９を形成し、共通電極１１及び突起１９を配向膜１２で覆った後に突起１９の部分のみ配向膜１２を除去しても良い。このとき配向膜１２の積層状態に関係なく、突起１９は確実に共通電極１１に接続され、且つ適正な形状のものが形成できるため、配向膜１２を除去する部分を最小限にすることができる。この突起１９は画素電極４のスリット６及び信号線３に対応して配置されるが、全ての突起１９が共通電極１１に接触しているのため、第二基板８の端部まで連続的に延在させなくても部分的に分割して設けても良い。そして画素電極４に電圧を印加したときは突起１９付近の液晶分子１４は第１実施例と同様に動作し、１画素内に複数のドメインを形成する。

【００３４】以上のように本発明では共通電極側に突起を形成したので、画素電極と共通電極の間に電界が発生した際に各画素内に複数のドメインを形成することができ、広視野角な液晶表示装置ができる。さらに突起を導電体で形成しているので突起が共通電極と同電位になり、不純物イオンが突起に集中的に吸着することを防止でき、また画素内の一部分に低誘電率の突起が存在するときに生じる電圧降下を防止でき、画素電極と共通電極の間に均一な電界を発生させることできる。

【００３５】なお、実施例では導電体の突起の場合で説明したが、突起を液晶の誘電率よりも高い誘電率を有する誘電体で形成してもよく、この場合も導電体の突起と同じ効果を得られる。また、本発明の突起の場合、突起は画素電極の端部付近に対向して配置されればよく、実施例以外の形態を取ることも可能である。

【００３６】

【発明の効果】本発明によれば、画素内に複数のドメインを形成するように突起を設けた場合でも、突起に不純物イオンが集中的に付着することを低減でき、焼付きを現象を防止できる。また突起に起因する電圧降下を減少させることができ、良好な表示を得ることができる。

【図面の簡単な説明】

【図１】本発明の第１実施例である液晶表示装置の第一基板の平面図である。

【図２】電界を印加していないときの液晶表示装置の断面図である。

【図３】電界を印加したときの液晶表示装置の断面図である。

【図４】第１実施例である液晶装置の画素電極と突起との位置関係を示した模式図である。

【図５】電圧を印加した際の突起付近に位置する液晶分子の動作を説明する図である。

【図６】第１実施例の突起の拡大断面図である。

【図７】第２実施例である液晶表示装置の画素電極と突起との位置関係を示した模式図である。

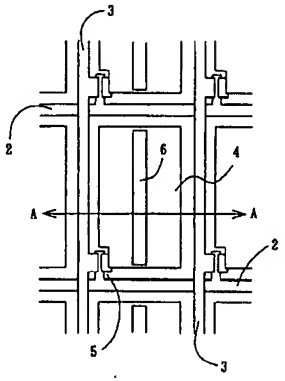
【図８】第３実施例である液晶表示装置の画素電極と突起との位置関係を示した模式図である。

【図９】第４実施例である液晶表示装置の電界を印加していないときの断面図である。

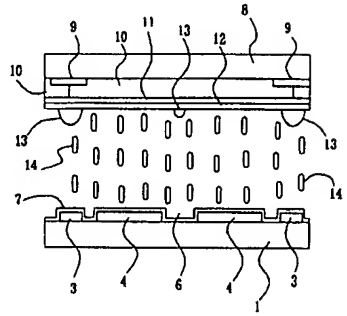
【符号の説明】

１　第一基板
２　走査線
３　信号線
４　画素電極
６、１５、１７　スリット
７、１２　配向膜
８　第二基板
１１　共通電極
１３、１６、１８、１９　突起
１４　液晶分子

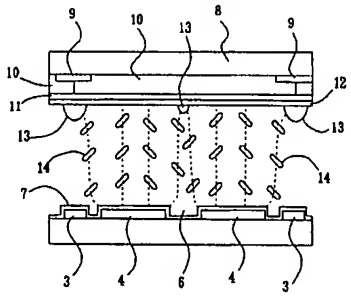
【図１】



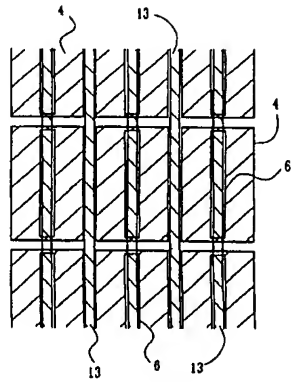
【図２】



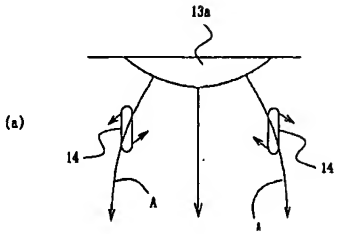
【図３】



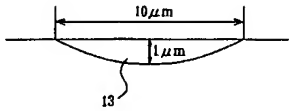
【図４】



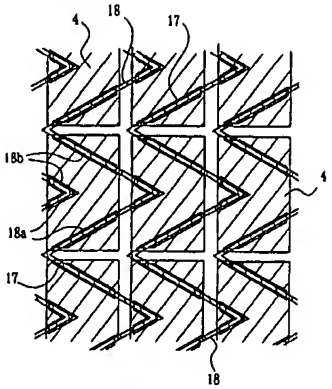
【図５】



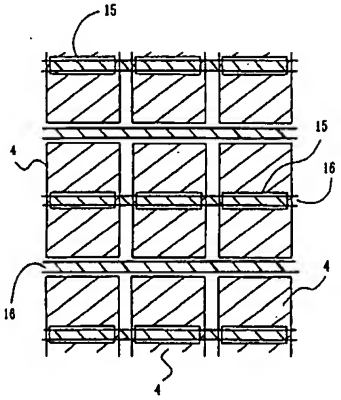
【図６】



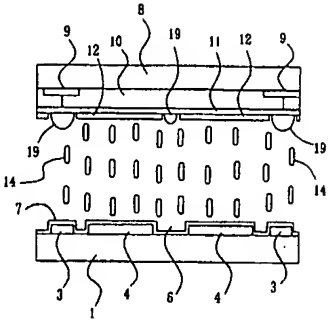
【図８】



【図７】



【図９】



フロントページの続き

(72)発明者　笹野　裕之
鳥取県鳥取市南吉方３丁目201番地　鳥取三洋電機株式会社内

(72)発明者　森　晋陸
鳥取県鳥取市南吉方３丁目201番地　鳥取三洋電機株式会社内

(72)発明者　田中　慎一郎
鳥取県鳥取市南吉方３丁目201番地　鳥取三洋電機株式会社内

Ｆターム(参考)　2H090 KA05 LA01 LA04 MA01 MA15
2H092 GA13 HA03 JA24 JB52 NA01
PA08 PA11 QA07